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Dry Matter Losses in Small Stack Silos as Affected
by Covering Techniques ^{1/}

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It has been repeatedly demonstrated that exposure of silage to air will result in spoilage. The invisible losses resulting from such exposure have often been ignored and seldom measured because they are less apparent and not directly measurable. The purpose of this experiment was to measure the invisible losses as well as the spoilage resulting from various surface treatments on small silage stacks.

Experimental Procedures and Results

Second cutting orchardgrass at 27% dry matter was stored on the ground in eight stacks of from 3.5 to 4.0 tons of fresh material in 1956. Corn silage was stored on the ground in 1.5 to 2.0 ton stacks in 1957 and 1958 at 29% and 26% moisture, respectively. The treatments applied to these stacks were selected to study the effects of variation in width, thickness and weighting of covering materials on dry matter losses. The specific treatments used are listed in Table 1.

The weight and percent dry matter of stored forage, recovered silage and recovered spoilage were determined for each stack. Recovered dry matter was subjectively classified as good or spoiled by the same individual in all experiments. The dry matter not recovered was considered to be lost as gas or liquid and has been classified as invisible losses. The major portion of this invisible loss in roofed and film or paper covered stacks is probably gaseous although no direct measurements of gas or liquid loss were made. All losses have been expressed in terms of dry matter per square foot to minimize the effect of differing size and depth of stacks.

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None of the covering techniques were considered entirely satisfactory since spoilage was not eliminated in any case. Lapping the seams of narrow widths of plastic reduced the effective exclusion of air to the extent that such material appears unsuitable for stack covers. The possibility of rodent damage and accidental puncture emphasized the importance of a continuous weighting material, even for covers of one piece. However, the data afforded an excellent opportunity to study the relative importance of spoilage and invisible losses.

The data in Table 1 are arranged in ascending order of spoilage losses. There appears to be no simple relationship between amounts of spoilage and invisible loss nor between either of these and total dry matter loss (spoilage plus invisible loss). Therefore, use of values for spoilage loss alone could lead one to an erroneous conclusion concerning the relative value of a sealing procedure. For instance, treatment 2 as compared to a control stack of the same year (7) resulted in the elimination of only 1.9 lbs. of spoiled dry matter per square foot and might therefore be considered of questionable economic importance. However, treatment 2 reduced total losses by 10.0 lbs. per square foot which is of considerable economic importance. The rather unsuccessful seal used in treatment 13 resulted in more loss from spoilage than the control of that year (8) and might be considered a detriment on that basis. However, total dry matter losses per square foot were reduced by 2.0 lbs.

The large invisible losses in the check or roofed corn stacks (7,8,9, 11,12) indicate the tendency to markedly underestimate losses in unsealed stacks. In the orchardgrass stacks this underestimation occurred in the check and the stacks not covered with felt paper (19,23,24,25). The treatment of felt paper plus soil (21) resulted in a decreased loss of 0.9 lbs. of dry matter per square foot over its check (23), yet it reduced total dry matter loss by 3.5 lbs. per square foot. Thus, the application of a felt paper barrier would be considered economically important.

Spoiled dry matter and the invisible losses were approximately the same for stacks protected by a roof (9,11) and their unroofed counterparts (7,8). Thus, dry matter losses were related more closely to infiltration of air than of water.

Invisible dry matter losses associated with spoiled silage at different depths were measured (1957 and 1958) in a shallow, open-box silo, 8' x 12' x 2', containing four layers of corn silage separated by fiberglass screening. All of the recovered dry matter was in the form of spoilage but the amounts and volume of spoilage differed markedly, depending upon location (Fig. 1). Volume shrinkage ranged from 50.0% in the top layer to 4.2% in the bottom layer, an average of 22.9% for the 24 inches of spoilage. However, invisible dry matter losses ranged from 80.0% to 28.9% from top to bottom, respectively, an average of 51.9%. In this experiment volume shrinkage would underestimate invisible losses by 56%. The amounts of invisible losses apparently increase with increasing intensity of exposure to air.

Table 1 - Treatment Effects on Small Stacks

Stack No.	Treatment	Dry Matter Losses (lbs./sq. ft.)			Invis- ible
		Total	Spoilage		
<u>Corn Stacks 1957 and 1958</u>					
1.	Vinyl chloride-sealed seams	158	1.4	.3	1.1
2.	35 ml. butyl rubber + soil on laps	157	1.2	.4	.8
3.	35 ml. butyl rubber-sealed seams	158	3.0	.8	2.2
4.	35 ml. butyl rubber-sealed seams	158	3.7	1.2	2.5
5.	1.5 ml. polyethylene + lime on laps	157	2.9	1.3	1.6
6.	Vinyl chloride-sealed seams	158	3.0	1.4	1.6
7.	Check-single packing	157	11.2	2.3	8.9
8.	Check-single packing	158	8.5	2.3	6.2
9.	Roofed - no cover	157	8.2	2.3	5.9
10.	Polyethylene fiber-stitched seams ^{1/}	158	5.5	2.4	3.1
11.	Roofed - no cover	158	10.1	2.5	7.6
12.	Check-repeated packing	157	7.9	2.6	5.3
13.	Polyethylene fiber-stitched seams ^{2/}	158	6.5	3.0	3.5
14.	20 ml. butyl rubber + lime on laps ^{4/}	157	5.6	3.7	1.9
15.	4 ml. polyethylene + sawdust overall ^{1/}	157	6.8	4.2	2.6
16.	1.5 ml. polyethylene + soil on laps ^{3/}	157	8.0	4.9	3.1
17.	1.5 ml. polyethylene + sawdust overall ^{3/}	157	8.3	5.3	3.0
<u>Orchardgrass Stacks 1956</u>					
18.	Felt paper + sawdust overall		2.3	1.5	.8
19.	Check		5.2	2.0	3.2
20.	Felt paper + lime overall		3.4	2.2	1.2
21.	Felt paper + soil overall		3.2	2.2	1.0
22.	Felt paper + lime on seams		3.0	2.7	.3
23.	Soil only		6.7	3.1	3.6
24.	Sawdust only		5.6	3.3	2.3
25.	Lime only		7.1	3.8	3.3

1/ Several small breaks at edge from cow hoof.

2/ Ripped at edge.

3/ Cover damaged by racoon.

4/ Middle strip blown off.

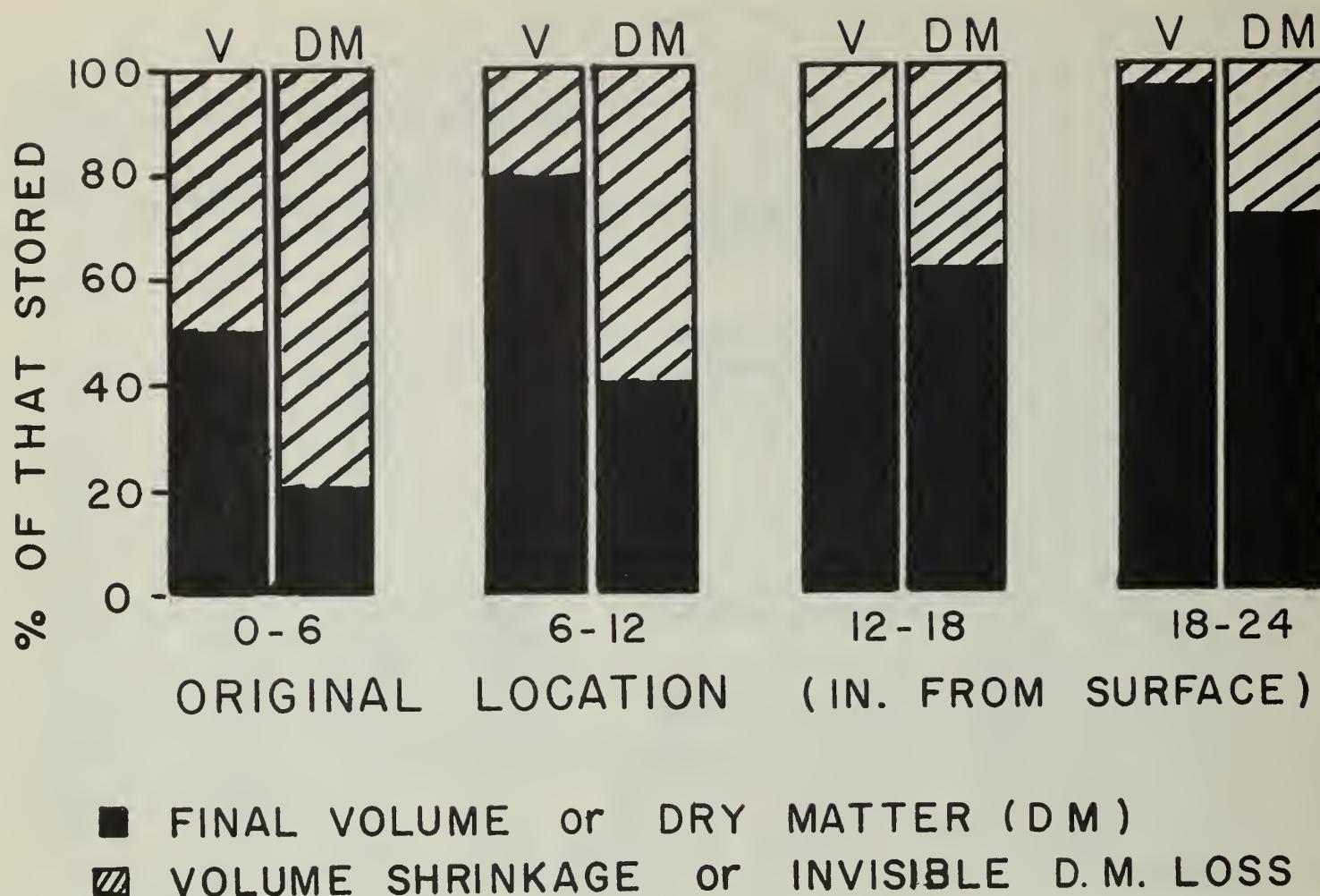


Fig. 1. Volume and dry matter distribution in spoiled corn silage.

Summary

Pilot stacks of corn and orchardgrass silage were treated with various covering techniques in 1956, 1957 and 1958 to ascertain the relative merits of sealing methods as well as to measure the invisible dry matter losses associated with them. All the covering procedures were considered unsatisfactory from the standpoint of eliminating top spoilage although all methods except a simple roof produced some improvement over no covering in total dry matter recovered. Treatments that resulted in similar amounts of top spoilage differed markedly in their effect on efficiency of total dry matter recovered because of a wide range in the amounts of invisible dry matter lost. Some treatments, appearing worthless since they did little to reduce the amount of spoilage, reduced invisible losses by as much as 8.1 lbs. per square foot. It was found that volume shrinkage in a completely spoiled stack underestimated the invisible losses of dry matter by 56%. It was concluded that total dry matter losses in surface silage could not be satisfactorily estimated from volume changes or observed spoilage since there was apparently no predictable relationship between these values and total losses.